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ABSTRACT

The purpose of this project was to produce an integrated program that effectively improves adult literacy, affects employment, enhances employability, and provides career adaptability. The goals directing these efforts were to design a series of modules for teaching reading, writing, and math, and to provide adults with basic employment skills. This tutorial is to improve the mathematics skills needed for electronics training. The three modules include basic algebra terms, evaluation of algebraic expressions, and scientific notation. Included in each module are objectives, a pretest, exercises, and a posttest. The modules within this project are appropriate for selected vocational clients as well as non-college attending adults such as those participating in Job Training Partnership Act programs. (MVL)

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ED3014419

A New Dimension In Learning

Adult Literacy Project

Mathematics For Electronics Tutorial Modules

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SE 050 134

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Sherman-Denison, Texas
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Introduction

It has been reported that 33 percent of the adult population is functionally illiterate working at or below the fourth grade level. The need for a successful adult literacy program is well established and verifies the need for new approaches to adult literacy.

The purpose of this project was to produce an integrated program that effectively improves adult literacy, affects employment, enhances employability, and provides career adaptability. The goals directing our efforts were: to design a series of personal/social skills modules; to design a series of modules for teaching reading, writing, and math, and; to design a series of modules providing adults with basic employment skills.

A task force of specialists including community college faculty and counselors, governmental agency representatives, and Coordinating Board personnel worked together to identify client needs, skill competencies needed to meet those needs, and to identify strategies for integration. The integration of these activities centered around the development of material which reinforces and compliments skills taught in each of the three areas. For example, the material used to teach the skills of reading also reinforces skills needed for personal/social development such as assertiveness training. Correspondingly, material used to teach the basic employment module is consistent with the client's chances of learning the competencies.

The modules within this project are appropriate for selected vocational clients as well as non-college attending adults such as those participating in Job Training Partnership Act programs.

Basic Algebra Terms Module

BASIC ALGEBRA TERMS MODULE

INTRODUCTION:

Most of us think of arithmetic as a group of rules: addition, subtraction, multiplication and division that are used on numbers made with the digits 1, 2, 3, 4, 5, 6, 7, 8, and 9. We can solve many kinds of problems with arithmetic. We can solve many more types of problems if we know simple algebra. In this module we will learn some of the "language" of algebra.

OBJECTIVE:

At the end of this module the student will demonstrate by means of fill-in-the-blank mastery of the basic terminology of algebra.

CONTENTS:

This module contains the following:

1. A pre-test with key
2. Discussion of basic algebra terminology with examples
3. A post-test with key

PROCEDURES:

The student will first take the basic algebra terms pre-test and grade his or her test with the key. If the student scores eight (or more) out of ten correct, he or she may skip this module. If the student scores seven or less out of ten items correct, then he or she will read and work through the module. Mastery of the module will be demonstrated by a score of eight (or more) out of ten correct on the post-test.

BASIC ALGEBRA TERMS

Pre-Test

INSTRUCTIONS:

Complete the following sentences using the terms listed below. No term will be used more than once.

order of signs of operation	product
coefficient	factors
one	B_1 , B_2
formula	variable
numerical coefficient	algebraic expressions

1. A _____ is the result of multiplying two or more numbers together. (Example: 15 is the _____ of 3 X 5).

2. _____ and _____ are read "B sub one" and "B sub two", or "B one" and "B two."

3. 4 and 5 are _____ of 20 since 4 X 5 = 20.

4. A _____ is a symbol (usually a letter of the alphabet) that represents an unknown number or numbers.

5. 7- (3 + 5) and x + yz are examples of _____ _____ _____.

6. In the expression 4xy each factor or group of factors is called the _____ of the remaining factors.

7. In the expression 4xy 4 is a _____ _____.

8. To find how much 20 ÷ 4 + 7 - 3 + 9 x 2 is, we multiply and divide first, and then we add or subtract. This is an example of_____ ____ _____ ____ _____.

9. In the expression xyz _____ is understood to be the numerical coefficient.

10. $P = I^2R$ is an example of a _____.

BASIC ALGEBRA TERMS

MODULE

Pre-Test Key

1. product
2. B_1, B_2
3. factors
4. variable
5. algebraic expressions
6. coefficient
7. numerical coefficient
8. order of signs of operations
9. one
10. formula

BASIC ALGEBRA TERMS

Algebra may be thought of as a general picture of what happens in arithmetic. In arithmetic we use numbers to find a specific amount. In algebra we study how numbers are used or how an answer to a problem is generally found. For example, a problem in arithmetic might be like the following:

Apples are 59¢ a pound. Sue wants 3 pounds. How much will she pay for 3 pounds of apples? We find the answer by multiplying 3 times 59¢ and find that Sue will pay 177¢ or $1.77 for the apples. Now think about buying apples at a new supermarket. Most newer stores have cash registers that are really computers that read a code and then calculate an amount. The apple problem becomes a type of algebra because the computer/cash register is given a rule which describes how to calculate the price of apples. In algebra the rule might look like this:

$$A = 59P$$

where A means the total cost of the apples bought and P means the number of pounds. The 59 stands for the cost per pound (in cents) of the apples. Next week if the price of apples changes to 49¢ a pound, the apple rule would look like this:

$$A = 49P$$

Letters or symbols used to represent amounts in a general way are known as literal numbers or general numbers. From geometry we know the area of a rectangle is the length times the width. If we use the letters A, l, and w to represent this rule, we have the following:

$$A = l \times w \text{ or } A = lw$$

In this example, A, l, and w are literal numbers. Together they form an expression called a formula. A special formula from electronics: $I = \frac{V}{R}$ represents Ohm's law. Ohm's law states, briefly, that the current in a certain part of a circuit is proportional to the voltage (potential difference) across that part of the circuit and inversely proportional to the resistance of that part. In the formula $I = \frac{V}{R}$, I represents the current, V represents the voltage, and R is the resistance. Formulas are very useful in many areas of study (electronics, nursing, and computer) because they express complex rules in simpler symbolic form.

In algebra we use many of the signs of operations from arithmetic. For example, +, -, X, ( ), /, and ÷ have the same meaning in algebra. However, in algebra we do not use X to mean multiply. This is because we will often use the letter x to stand for unknown numbers. To use x one time to mean

multiplication and x another time to mean an unknown number would be very confusing! Therefore, in algebra we do not use x to mean multiply. How do we represent multiplication? We use a raised dot: • , parenthesis, or positioning of letters to mean multiplication. For example: in algebra, a times b may be written (1) a • b, or (2) a(b), or (3) (a)b, or (4) (a)(b), or (5) ab. As in example (5), two or more letters written very "close" mean multiply.

Examples: IV means I times V
xy means x times y
abc means a times b times c

Another idea from arithmetic that is used in algebra is the order of signs of operations. Generally, we multiply and divide first, and then we add and subtract, i.e., $20 \div 5 - 3 + 6 \times 2 + 7 = 4 - 3 + 12 + 7 = 20$. We divide 20 by 5, and we multiply 6 by 2. We next subtract 3 from 4, add 12, and then add 7 to get 20. If there are any parentheses we calculate what is in the parentheses first, and then we use order of signs of operations.

$20 \div 5 - 3 + 6 \times 2 + 7$ is an example of an algebraic expression. An algebraic expression represents a number by the signs and symbols of algebra. An algebraic expression made only of signs

and numbers is a numerical algebraic expression. An algebraic expression containing general numbers (usually letters) is a literal algebraic expression.

Algebraic Expressions

Numerical Algebraic Expressions	Literal Algebraic Expressions
$5 + 3 + (2 + 7)$	$x + 2yz$
$15 - 3(3 + 4)$	$3 - abc$
$20-2(8 - 5)$	$I^2 R$

Note: Although x + 2yz contains a "number"--namely two, x + 2yz is still considered a literal algebraic expression. Numerical algebraic expressions have no letters in them. We have a special name for letters or symbols used to stand for unknown numbers; these letters or symbols are called variables. In the algebraic expression x + 2yz; x, y and z are all variables, and 2 is called a numerical coefficient.

Some other words from arithmetic that are used in algebra are product and factor. In arithmetic, a product is the result of multiplying two or more numbers. In algebra, a product is the result of multiplying two or more numbers or variables.

Examples: 3xy is the product of multiplying 3 times x times y.
abc is the product of a times b times c.

6cd is the product of 3 times 2 times c times d.

Notice we write the numerical coefficients in front of the variables; that is, 6 is the numerical coefficient of 6cd. If two or more numbers are multiplied together, each of them, or a product of any combination of them, is a factor of the product. In algebra if two or more numbers or variables are multiplied together, then each of them or the product of any combination of them is a factor of the product. Since 3•2•c•d is 6cd, then 3, 2, c, d, 6, 6c, 6d, cd, and so on are factors of 6cd. In the expression abc, a, b, c, ab, ac, bc, and abc are all factors of abc.

Coefficients are related to the terms product and factor. Any factor of a product is called the coefficient of the product of the other factors. Thus, 3 is a coefficient of 2cd (in using 6cd once again), and 6c is a coefficient of d. We call the "number" part of an expression a numerical coefficient. In 6cd, 6 is the numerical coefficient. What about an expression such as abc? If someone says they have an apple, you know he or she has one apple. Similarily, we say abc means 1abc so the numerical coefficient of abc is one. We do not usually write a numerical coefficient of one. That means 1xy is written xy, 1wv is written wv, etc.

Another notation used in algebra is the subscript. Subscripts are small letters or numbers written below and to the right of a variable. Variables with subscripts are usually related to each other in some way. For instance, if we were comparing three resistances we would call them all R because they are all resistances, and we would use subscripts R_1, R_2, and R_3 to show they are related but different. R_1, R_2 and R_3 are read "R sub one", "R sub two", "R sub three", or "R one", "R two", and "R three." Subscripts are always to the right and below a variable. R_2 and R^2 symbolize two different ideas. R_2 is "R sub two." R^2 is read "R squared" or "R to the second power" and means R times R.

In this module we have looked at ten important terms of algebra: signs of order of operations, algebraic expessions, product, factor, numerical coefficient, coefficients, variables, formula, literal numbers, and subscripts. Use the module post-test to see if you understand these terms.

BASIC ALGEBRA TERMS MODULE

Post-Test

Complete the following sentences:

1. The symbol I is read _____.

2. Symbols or letters used to represent unknown numbers are called _____.

3. 5 + (8 - 2) and 3x + y are both examples of _____ _____.

4. 4 is a _____ of 20abc.

5. The result of multiplying two or more numbers or variables together is a _____.

6. 5 is the _____ _____ of 5yz.

7. To calculate 16 2 + 5 - 3 + 2 X 4, we multiply and divide first, and then we add and subtract. This is an example of _____

_____.

8. The numerical coefficient of xy is _____.

9. Any factor of a product is called the _____.
of the product of the remaining factors.

10. $A = \frac{h}{2}(a + b)$ Where A is area, h is height, and
a and b are bases is an example of a _____.

BASIC ALGEBRA TERMS MODULE

Post-Test Key

1. "I sub two" or "I two"
2. variables
3. algebraic expessions
4. factor
5. product
6. numerical coefficient
7. order of signs of operation or order of operations
8. one
9. coefficient
10. formula

Evaluation of Algebraic Expressions Module

EVALUATION OF ALGEBRAIC EXPRESSIONS
MODULE

INTRODUCTION:

Evaluation of algebraic expressions is a very important skill. Most all jobs that use algebra will use evaluation. In algebra to evaluate an expression means to find its value.

OBJECTIVE:

At the end of this module the student will correctly evaluate algebraic expressions containing one or more variables.

CONTENTS:

This module contains the following:

1. A pre-test with key
2. Discussion and examples of the evaluation of an algebraic expression
3. A post-test with key

PROCEDURES:

The student will first take the module pre-test and grade his or her test with the key. If the student gets eight (or more) out of ten problems correct, he or she may go on to the next module. If the student gets seven or less correct, then he or she will need to go through the module. Mastery of this module will be demonstrated by scoring eight (or more) out of ten correct on the post-test.

EVALUATION OF ALGEBRAIC EXPRESSIONS

MODULE

Pre-Test

1. Find the value of $x + y$ if $x = 5$ and $y = 7$.
2. Evaluate $3y - z$ if $y = 4$ and $z = 2$.
3. Find the value of $\frac{V}{R} - 2I$ if $V = 20$, $R = 2$, and $I = 3$.
4. Find R if $R = R_1 + R_2 + R_3$ and $R = 5$, $R_2 = 3$, $R_3 = 2$.
5. What is the value of A if $A = 3xyz$ and $x = 3$, $y = 7$, $z = 11$?

In problems 6 through 10 let $a = 3$, $b = 5$, and $c = 4$.

Evaluate the following expressions.

6. $\frac{4a - c}{Bl}$
7. $\frac{ac}{2} + 3b$
8. $(a + c)(b + 2)$
9. $6abc \div 10$
10. $5a + 3b - 6c$

EVALUATION OF ALGEBRAIC EXPRESSIONS

MODULE

Pre-Test Key

1. 12
2. 10
3. 4
4. 10
5. 693
6. 2
7. 21
8. 49
9. 36
10. 6

EVALUATION OF ALGEBRAIC EXPRESSIONS

MODULE

The numerical value of an algebraic expression is found when each literal number in the expression is given a specific value. The process of finding this numerical value is called evaluation.

Example 1. Find 2ab if a = 3 and b = 5

Solution: $2ab = 2(3)(5) = 30$

Example 2. Evaluate 15V - 5R if V = 3 and R = 2.

Solution: $15V - 5R = 15(3) - 5(2)$

$= 45 - 10$

$= 35$

Example 3: Find the value of $\frac{V}{R} - 2I$ if V = 30, R = 2,

and I = 3

Solution: $\frac{V}{R} - 2I = \frac{30}{2} - 2(3)$

$= 15 - 6$

$= 9$

Example 4. Calculate the value of 3a + 5bc if a = 2, b = 3,

and c = 1

Solution: $3a + 5bc = 3(2) + 5(3)(1) = 6 + 15 = 21$

Notice that in the examples 1-4 the following words are used to signal evaluation: find, evaluate, find the value of, and calculate the value of. In what other way are these examples alike? In each example the solution was always a number.

Evaluation Rules

1. Rewrite the expression you are evaluating.
2. Substitute in the specific values for the literal numbers.
3. Calculate being sure to lay out your work so that someone else can follow how you worked the problem.

Remember, when evaluating an expression, you will be given an algebraic expression and the values for the literal numbers.

Example 5: Evaluate $3a - 2b$ if $a = 5$ and $b = 3$

tells you what to do — algebraic expression — values of the literal numbers

Solution:

Step 1 recopy expression		Step 2 put in values		Step 3 calculate
$3a - 2b$	=	$3(5) - 2(3)$	=	$15 - 6 = 9$

Notice how each step is connected by the equal sign. Using the equal sign helps you and anyone who reads your work to follow how you worked the problem. Let's look at some other examples. Be sure to take note of how to set out a problem so that anyone can follow your work.

Example 6: Evaluate $24V + 2ir$ if $V = 10$, $i = 3$, and $r = 6$

Solution: $24V + 2ir = 24(10) + 2(3)(6)$

$= 24 + 36$

$= 60$

Example 7: Find the value of $3b - 6c + 8a$ if $b = 7$, $c = 1$, and $a = 3$

Solution: $3b - 6c + 8a = 3(7) - 6(1) + 8(3)$

$= 21 - 6 + 24$

$= 39$

Example 8: Calculate the value of $4a + 5(2b - 3c)$ if $a = 3$, $b = 7$, $c = 2$

Solution: $4a + 5(2b - 3c) = 4(3) + 5(2 \cdot 7 - 3 \cdot 2)$

$= 12 + 5(14 - 6)$

$= 12 + 5(8)$

$= 12 + 40$

$= 52$

Notice in Example 8 that we used the order of signs of operations. The parentheses around 2b - 3c told us to calculate that amount before we multiplied by 5.

Review the examples in this module and work the exercises. Test your understanding of this module by working and grading the post-test.

EVALUATION OF ALGEBRAIC EXPRESIONS

EXERCISES

1. Evaluate $\frac{V}{R} - 2I$ if $V = 40$, $R = 4$, and $I = 1$

2. Find the value of $2a + 3b - c$ if $a = 3$, $b = 4$, and $c = 5$

3. Evaluate $\frac{V - w}{i}$ if $V = 300$, $w = 150$ and $i = 5$

4. Find the value of $\frac{R}{PF}$ if $R = 360$, $P = 2$, and $F = 9$

For problems 5 through 10 evaluate each expression with $a = 8$, $b = 2$, $c = 4$, and $d = 1$.

5. $2a + b$

6. $2a - 3c$

7. $3a + 2b - c + 5d$

8. $5ad - 6b$

9. $\frac{2a + 3b}{2d}$

10. $a + 3(b + c - d)$

EVALUATION OF ALGEBRAIC EXPRESSIONS

SOLUTIONS TO THE EXERCISES

1. $\frac{V}{R} - 2I = \frac{40}{4} - 2(1) = 10 - 2 = 8$

2. $2a + 3b - c = 2(3) + 3(4) - 5$
$= 6 + 12 - 5$
$= 18 - 5$
$= 13$

3. $\frac{V - w}{i} = \frac{300 - 150}{5} = \frac{150}{5} = 30$

4. $\frac{R}{PF} = \frac{360}{2(9)} = \frac{360}{18} = 20$

5. $2a + b = 2(8) + 2 = 16 + 2 = 18$

6. $2a - 3c = 2(8) - 3(4) = 16 - 12 = 4$

7. $3a + 2b - c + 5d = 3(8) + 2(2) - 4 + 5(1)$
$= 24 + 4 - 4 + 5$
$= 28 - 4 + 5$
$= 24 + 5$
$= 29$

8. $5ad - 6b = 5(8)(1) - 6(2) = 40 - 12 = 28$

9. $\frac{2a + 3b}{2d} = \frac{2(8) + 3(2)}{2(1)} = \frac{16 + 6}{2} = \frac{22}{2} = 11$

10. $a + 3(b + c - d) = 8 + 3(2 + 4 - 1) = 8 + 3(5)$
$= 8 + 15$
$= 23$

EVALUATION OF ALGEBRAIC EXPRESSIONS

Post-test

1. Evaluate $8V - 5ir$ if $V = 10$, $i = 2$, $r = 7$

2. Find the value of $\frac{4V - W}{i}$ if $V = 30$, $W = 20$ and $i = 5$

3. Calculate the value of $2a - 3b + c$ if $a = 5$, $b = 2$ and $c = 7$

4. Evaluate $\frac{B}{A+C}$ if $B = 240$, $A = 6$ and $C = 2$

For problems 5-10 evaluate each expression with $a = 10$, $b = 5$, $c = 1$ and $d = 2$.

5. $3a - 2b$

6. $6b + 3d$

7. $a + 2b + 4c - 3d$

8. $ab - 3cd$

9. $\frac{2a + 2b}{3d}$

10. $a + 5(b + c - d)$

EVALUATION OF ALGEBRAIC EXPRESSIONS

Post-test Key

1. $8V - 5ir = 8(10) - 5(2)(7)$

$= 80 - 70$

$= 10$

2. $\frac{4V - W}{i} = \frac{4(30) - 20}{5} = \frac{120 - 20}{5} = \frac{100}{5} = 20$

3. $2a - 3b + c = 2(5) - 3(2) + 7$

$= 10 - 6 + 7$

$= 11$

4. $\frac{B}{A+C} = \frac{240}{6+2} = \frac{240}{8} = 30$

5. $3a - 2b = 3(10) - 2(5) = 30 - 10 = 20$

6. $6b + 3d = 6(5) + 3(2) = 30 + 6 = 36$

7. $a + 2b + 4c - 3d = 10 + 2(5) + 4(1) - 3(2)$

$= 10 + 10 + 4 - 6$

$= 18$

8. $ab - 3cd = 10(5) - 3(1)(2) = 50 - 6 = 44$

9. $\frac{2a + 2b}{3d} = \frac{2(10) + 2(5)}{3(2)} = \frac{20 + 10}{6} = \frac{30}{6} = 5$

10. $a + 5(b + c - d) = 10 + 5(5 + 1 - 2)$

$= 10 + 5(4)$

$= 10 + 20$

$= 30$

Scientific Notation

SCIENTIFIC NOTATION

INTRODUCTION: Electronic engineers and technicians are often required to work with very small numbers such as tiny fractions of volts to very large numbers such as kilowatt hours. Powers of 10 and scientific notation are used to write these numbers in a more convenient form.

OBJECTIVE: At the end of this module, the student will be able to write any real number as a number in scientific notation with three significant digits.

CONTENTS: This module contains the following:

1. A pre-test with key
2. Discussion and examples of scientific notation
3. A post-test with key

PROCEDURES: The student will first take the scientific notation pre-test and grade his or her test with the key. If the student answers eight out of ten (or more) correctly, he or she may skip this module. If the student scores seven out of ten items, or lower, then he or she will read and work through the module. Mastery of the module will be

demonstrated by eight out of ten correct on the post-test.

SCIENTIFIC NOTATION MODULE

Pre-Test

Instructions: Write the following numbers in scientific notation.

Write your answers with three significant digits.

1. 425,000

2. 0.05976

3. 0.0000001987

4. 467

5. 3.279

6. 1,127,000,000

7. 0.001076

8. 5,742

9. 10.0

10. 23

SCIENTIFIC NOTATION

Pre-Test

Key

1. 4.25×10^{5}

2. 5.98×10^{-2}

3. 1.99×10^{-7}

4. 4.67×10^{2}

5. 3.28×10^{0}

6. 1.13×10^{9}

7. 1.08×10^{-3}

8. 5.74×10^{3}

9. 1.00×10^{1}

10. 2.3×10^{1}

SCIENTIFIC NOTATION MODULE

Scientific notation is a great way to write very large or very small numbers in a more easily used form. Scientific notation also allows us to perform calculations like multiplication and division on these numbers without getting bogged down with too many zeros. For example, the distance from the earth to the sun is 93 million miles or 93,000,000 miles. In scientific notation 93,000,000 miles is 9.3×10^7 miles. In another module we will look at how to multiply that 93 million miles by 574 million miles without getting lost in zeros. In arithmetic, we would multiply in the following manner and get:

$$\begin{array}{r} 574,000,000 \\ \times\ 93,000,000 \\ \hline 53,382,000,000,000,000 \end{array}$$

53,382,000,000,000,000 is certainly not a very convenient number to write or think about. However, in scientific notation it is just 5.3382×10^{16}. Any real number, regardless of how small or large, can be written in scientific notation.

The model for a number written in scientific notation is

$$N \times 10^P$$

where $1 \leq N < 10$ (N is less than 10 but greater than or equal to 1), and p is the number of places the decimal in

the original number had to be moved so that $1 \leq N < 10$.

If the decimal is moved to the right, then p is negative. If the decimal is not moved at all, the p is zero. Finally, if the decimal is moved to the left then p is positive. The term used for p is exponent. For example, 10^3 is read "10 to the third power" and means 10 x 10 x 10. We also say the exponent on 10 is 3.

Let's look at the three types of numbers we will express in scientific notation.

TYPE 1: Numbers less than 1

Numbers less than 1 will always have negative exponents on the 10 when they are written in scientific notation. For example, 0.00563 is written 5.63×10^{-3} in scientific notation. To write a number less than 1 in scientific notation, use the following rule:

Rule 1:

To write a decimal fraction in scientific notation move the decimal point to the right until you have a number between 1 and 10. Count the number of places to the original decimal point. The number of places counted is the negative power of 10.

Examples:

$0.0857 = 8.57 \times 10^{-2}$

(The decimal was moved 2 places to the right from between the 2 zeros to between 8 and 5 so the power on the 10 is -2.)

$0.00000543 = 5.43 \times 10^{-6}$

(The decimal was moved 6 places to the right so the power on 10 is -6.)

$0.00947 = 9.47 \times 10^{-3}$

(The decimal was moved 3 places to the right so that we get 10^{-3}.)

TYPE 2: Numbers between 1 and 10

Numbers between 1 and 10 (where 1 is included but 10 is not) will have zero as the exponent on 10 when written in scientific notation. In scientific notation, we would write 1 as 1×10^{0}. We will write 1.0 as 1.0×10^{0}. We will write 10 as 1.0×10^{1} in scientific notation. This rule is an agreement since we could write 10 as 10×10^{0} but it is less confusing if we agree that 10 will be 1.0×10^{1} in scientific notation. The rule we use for numbers between 1 and 10 is as follows:

Rule 2:

To write a number between 1 and 10 in scientific notation we do not move the decimal (except for 10.), and we multiply the number by 10 to the zero power. We will write 10 as 1.0×10^{1}.

Examples:

$5.43 = 5.43 \times 10^{0}$

$4.09 = 4.09 \times 10^{0}$

$5 = 5 \times 10^{0}$

$$3.11 = 3.11 \times 10^{0}$$

$$1.00 = 1.00 \times 10^{0}$$

$$10 = 1.0 \times 10^{1}$$

The reason we do not move the decimal is because we want our answer in scientific notation to fit the model $N \times 10^{P}$. For numbers between 1 and 10, N will automatically be between 1 and 10 without having to move the decimal at all.

Type 3: Numbers larger than 10.

Numbers larger than 10 will always have a positive exponent on the 10 when they are written in scientific notation. These numbers will still fit our model for scientific notation:

$$N \times 10^{P}$$

The rule for these numbers is as follows.

Rule 3:

To write a number larger than 10 in scientific notation move the decimal point to the left until you have a number between 1 and 10. Count the number of places to the original decimal point. The number of places counted is the positive power on 10.

Examples:

$$345 = 3.45 \times 10^{2}$$

$$94{,}200 = 9.42 \times 10^{4}$$

$$603 = 6.03 \times 10^{2}$$

$$425{,}000 = 4.25 \times 10^{5}$$

$$1{,}276{,}000 = 1.276 \times 10^{6}$$

Notice the following facts about numbers written in scientific notation. Numbers between 1 and 10 (1 in included but 10 is not) will have zero as the exponent on 10.

Examples:

$$3.09 = 3.09 \times 10^{0}$$

$$2.17 = 2.17 \times 10^{0}$$

$$9.97 = 9.97 \times 10^{0}$$

This is because the decimal does not move anywhere. The number is in correct form, but it does need to be multiplied by 10^{0}. (Fact: 10^{0} is 1 so the value of the number has not been changed.) Remember that in scientific notation, 10 is 1.0×10^{1}.

Another important fact to remember about numbers written in scientific notation is that numbers less than 1 will have a negative exponent on the 10, and numbers 1 or larger will have zero or a positive number as the exponent on 10.

The model for a number written in scientific notation is:

$$N \times 10^{P}$$

Where N is a number between 1 and 10 (1 is included but 10 is not), and p is the number of places the decimal had to be moved in the original number so that N would be between 1 and 10.

If the decimal is moved to the right, the exponent is negative. If the decimal is not moved at all, the exponent is zero. Finally, if the decimal is moved to the left, the exponent is positive.

Before we look at more examples, let's review significant digits and rounding. The digits that are known to be correct in a measurement are called <u>significant digits</u>. The digits 1, 2, 3, 4, 5, 6, 7, 8 and 9 are always significant. The digit 0 may or may not be significant. We use the following rules to determine if 0 is significant or not.

1. Zeros that come between two other digits are significant such as in 307 (three significant digits) or 20.05 (four significant digits).

2. If the zero's function is only to place the decimal, it is

not significant.

Examples: .000054 (2 significant digits)

place holders

or

57,000. (2 significant digits)

place holders

3. If the zero's function is more than to place the decimal, it is significant.

Examples: 0.000540 (3 significant digits)

↑ significant

or

57,000.04

These zeros are significant since they come between two other nonzero digits.

Rules 2 and 3 can cause some confusion, such as how many significant digits are in 57,000 (measured to the exact unit). We use scientific notation to avoid this confusion.

Examples: 5.7×10^4 has 2 significant digits

5.7000×10^4 has 5 significant digits

Numbers obtained by counting are considered to be exact and are correct to any number of significant digits.

Examples: Two significant digits: 53, 5.0×10^2, 0.060

Three significant digits: 537, 603, 3.00×10^2, 0.00700

Four significant digits: 500.3, 5.000×10^1, 0.02345

To round off numbers, we will use the following rules:

1. Add 1 to the last digit retained if the first digit to be dropped is 6 or more.
   Example: 43756 rounds to 43760 if we are rounding to the tens place.

2. If the first digit to be dropped is less than 5, replace the dropped digits with zero.
   Example: 43524 rounds to 43520 if we are rounding to the tens place.

3. If the first digit to be dropped is 5, we add 1 to the retained digit if it is odd, and we do not add 1 if the retained digit is even.
   Examples: 35452 rounds to 35400 if we are rounding to the hundreds place.
   or
   76351 rounds to 76400 if we are rounding to the hundreds place.

If we wish to write a number in scientific notation with three significant digits, we first write the number in scientific notation

and then we rewrite N so that we have three significant digits.

Table I.

Number	Scientific Notation	Scientific Notation (3 significant digits)
2,726,345	2.726345 x 10	2.73 x 10
5024	5.024 x 10	5.02 x 10
0.004372	4.372 x 10	4.37 x 10
0.0000010752	1.0752 x 10	1.08 x 10
8,743,000	8.743000 x 10	8.74 x 10
0.0030856	3.0856 x 10	3.08 x 10

Review the rules for rounding and significant notation before you do the exercises. After completing and checking the exercises, you may test your understanding by taking the module post-test.

EXERCISES

INSTRUCTIONS: Express the following numbers to three significant digits and write them in scientific notation.

1) 645,000
2) 547,801
3) 5.039
4) 2,019,000
5) 0.576
6) 6574
7) 8,743,000
8) 0.0009176
9) 0.00854
10) 0.0129
11) 59,235
12) 0.096432
13) 0.00000867
14) 259
15) 0.964
16) 5.89
17) 8
18) 0.367
19) 0.0963
20) 259
21) 0.919
22) 4,382
23) 2,019,000,000
24) 1,209,000,000,000,000
25) 0.00000000000987

EXERCISE - KEY

1. 6.45×10^{5}
2. 5.48×10^{5}
3. 5.04×10^{0}
4. 2.02×10^{6}
5. 5.76×10^{-1}
6. 6.57×10^{3}
7. 8.74×10^{6}
8. 9.18×10^{-4}
9. 8.54×10^{-3}
10. 1.29×10^{-2}
11. 5.92×10^{4}
12. 9.64×10^{-2}
13. 8.67×10^{-6}
14. 2.59×10^{2}
15. 9.64×10^{-1}
16. 5.89×10^{0}
17. 8.00×10^{0}
18. 3.67×10^{-1}
19. 9.63×10^{-2}
20. 2.59×10^{2}
21. 9.19×10^{-1}
22. 4.38×10^{3}
23. 2.02×10^{9}
24. 1.21×10^{15}
25. 9.87×10^{-12}

SCIENTIFIC NOTATION

Post-Test

Instructions: Write the following numbers in scientific notation. Write your answers with three significant digits.

1. 3,472

2. 0.0917

3. 0.176

4. 2,470,000,000

5. 0.00000292

6. 35

7. 18,407

8. 119,000

9. 108,000

10. 5.65

SCIENTIFIC NOTATION

Post - Test

Key

1. 3.47×10^{3}

2. 9.17×10^{-2}

3. 1.76×10^{-1}

4. 2.47×10^{9}

5. 2.92×10^{-6}

6. 3.50×10^{1}

7. 1.84×10^{4}

8. 1.19×10^{5}

9. 1.08×10^{5}

10. 5.65×10^{0}